cause I have not been able to find information of this sort in print.

It is to be expected that what now seem satisfactory devices for carrying on the work of the garden will prove capable of much improvement in the future, aided by experience gained from other gardens as well as in our own. It will always be one of the chief aims of the garden at Homewood to discover what a garden is capable of doing for the botanical student and investigator and how it can do this best.

DUNCAN S. JOHNSON

THE RELATION OF APPLIED SCIENCE TO EDUCATION[1]

THE dative of indirect object is used with most Latin verbs compounded with ad, ante, con, in, inter, ob, post, pre, pro, sub and super, and sometimes circum; the elements essential for the growth and maturity of the plants which furnish, directly or indirectly, the food and clothing for the human race are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, magnesium, calcium, iron and sulfur, and possibly chlorin, and I think I am expected to discuss the general question whether there may be as much educational development in a study of these elements, for example, and of their application to the preservation of American soil and to the preservation of American prosperity, civilization and influence, as in learning a like number of Latin prepositions and their application to language development, and to philological research.

The question is, whether the culture of corn roots and the investigation of corn-root insects and diseases or the culture of clover roots, with their millions of symbiotic bacteria and their wonderful power to transform much of the impoverished lands of that part of Illinois whose name is "Egypt," and much of the exhausted and abandoned lands of India, whose fame is famine, into fruitful and valuable lands, may serve as well for the development of the mind and for the advancement of education and civilization, as the culture of Greek roots, and Sanskrit roots, and Hindu roots, from which we learn that the people of India, of whom only one man in ten, and only one woman in a hundred, are able to read and write—from which we learn that these people are our own cousins; that many words still live in India and in America that have witnessed the first separation of the northern and the southern Aryans; and, in the words of Max Müller:

> These are witnesses not to be shaken by any cross examination. The terms of God, for house, for father, mother, son, daughter, for dog and cow, for heart and tears, for axe and tree, identical in all the Indo-European idioms, are like the watchwords of soldiers. We challenge the seeming stranger, and, whether he answer with the lips of a Greek, a German or an (East) Indian, we recognize him as one of ourselves. There was a time when the ancestors of the Celts, the Germans, the Slavonians, the Greeks and Italians, the Persians and Hindus, were living together beneath the same roof.

Why has the southern Aryan civilization developed but one school for every five villages, while the northern Aryan, save in Russia, opens to every child the door of the school which leads on, for those who will, to the college and university? Why? Because only a prosperous nation can afford the trained intelligence or education of its people.

Education in America is not the cause, but the product, of our prosperity; and, thus far, the prosperity of this nation is due to our conquest of the former inhabitants and to the consequent acquisition of the great natural resources of this country,

[1] One of the papers presented February 19, 1910, before the Illinois State Academy of Science in the symposium on the "Relation of Pure and Applied Science."

including, primarily, vast areas of rich virgin soil; and, secondarily, immense supplies of timber, coal, and iron.

American prosperity has done more than educate Americans; it has educated western Europe, first of all by relieving the over-crowded condition of those impoverished lands, and subsequently by making large direct contributions to European prosperity, in supplying cheap food and fertilizer and a good market for European products, manufactured in large part from the low-priced raw materials secured from this and other new countries.

Applied science has already made some contributions to American education and civilization, and so far as its use in the schoolroom is concerned, applied science, as an educative agency, is not exceeded in value by any other instrumentality. Its very general acceptance by teachers and students in our leading educational institutions does not prove its value, but does prove that its value is being appreciated; and I need not remind you that pure science is the foundation of applied science.

While education has not been in any sense the prime cause of our national prosperity, the future prosperity of America depends absolutely upon the application of science and education to industry. For three full centuries America has lived upon the spoils of conquest and inherited wealth and resources, and for three full centuries America has wasted her substance or scattered it abroad. But even among nations there is a limit to inherited wealth. The land which flowed with milk and honey is now almost a barren waste, supporting only wandering bands of marauding Arabs and villages of beggars.

Truly the two most characteristic attributes of rich young America are wastefulness and bigotry. Other nations have risen to positions of world power and influence and fallen again to poverty, ignorance and insignificance. Thus far American history has been in large part a repetition of the history of nations long since gone to decay.

Following the rise and fall of the great empires of Babylon, of Carthaginia and of Greece, the Roman Empire also rose and fell. From what cause? Some tell us that the fall of those great empires was due to the development of pride and immorality among their peoples, forgetting the fact that civilization tends rather toward peace and security, and that universal education depends and must depend upon material prosperity. Poverty is at once helpless and soon ignorant.

History tells us that Roman agriculture declined until a bushel of seed brought only four bushels in the harvest—declined until the high civilization of the Mediterranean countries passed into the dark ages which covered the face of the earth for a thousand years, until the discovery of a new world brought new supplies of food, renewed prosperity, and new life and light to western Europe; but the dark ages still exist for most of our own Aryan race in Russia and in India, where, as an average, day by day, and year by year, more people are hungry than live in the United States, where the average wage of a man is fifty cents a month, where famine rages always, and where the price of wheat sometimes rises to a point where six months' wages of a working man are required to buy one bushel. This is the condition where the absolute needs of the population exceed the food supply; and just so sure as the intelligent and influential men and women of America continue to ignore the material foundation upon which national prosperity depends, just so sure will future dark ages blot out American civilization.

That vast areas of land that were once

cultivated with profit in the original thirteen states are now agriculturally abandoned is common knowledge; that much of the land in all adjoining states is in the process of abandonment is known to many; and that the common lands in the great agricultural regions in central United States are even now in process of the most rapid soil depletion ever witnessed is known to all who possess the facts.

Already the question of food has begun to exert pressure in this country. Already the masses, the common people, the "ninety per cent.," must consider a reduction in their standard of living. Poverty and degeneracy are even now making such demands upon the revenues of the state that education and research already suffer from inadequate support; and the only hope of the future lies in the application of science and education to the control of industry and to the control of population; and let us never forget that agriculture is the basis of all industry, and that the fertility of the soil is the absolute support of every form of agriculture.

Some will say that the economic conditions have been such that the depletion of the lands of the eastern states has been a necessary sequence, and that the restoration of those lands will now follow as an economic necessity. I beg of you, do not accept any such theoretical deductions. If systems of permanent progressive agriculture are ever to be adopted anywhere in this country, it must be done while the landowners are still prosperous. Some investment is necessary for the restoration of depleted soil, and poverty makes no investments. Much of the abandoned lands of America are far past the point of possible self-redemption. They were depleted not because of any economic necessity, but because of ignorance, and the fault lies not with the farmers and land owners, but with the educators who even until the present generation have taught almost everything except the application of science to agriculture. The fault lies also with the statesmen who, as James J. Hill says, have "unduly assisted manufacture, commerce and other activities that center in cities, at the expense of the farm."

There was no need whatever that the cultivable farm lands of the eastern states should have been depleted. Lying at the door of our greatest markets, with the application of knowledge and with such encouragement as should have been given, those lands could easily have been preserved and even increased in fertility until their present value would have been not five dollars, but five hundred dollars an acre.

Even now are the young men of the United States putting ninety million dollars a year into Canadian farms. Why? Because they were not taught in the schools that by investing those millions in the application of science to agriculture they can remain in the United States and secure greater profit and also save our soils from depletion; yes, make our partially depleted lands even more productive than they ever were, and at the same time provide the food that will soon be required to feed our own children.

Why do we permit the annual exportation of more than a million tons of our best phosphate rock, for which we receive at the mines the paltry sum of five million dollars, carrying away from the United States an amount of the only element of plant food we shall ever need to buy, that, if retained in this country and applied to our own soils, would be worth not five million, but a thousand million dollars, for the production of food for the oncoming generation of Americans?

Why this exportation? Because the present owners of American land learned only the art of agriculture and were never taught the science of farming; and it may well be repeated that the responsibility rests not with the farmer, but with the statesman and the educator.

Note well the following facts:

During the past dozen years the average acreage in corn and wheat in the United States has been increased by 30 per cent.; but notwithstanding the enormous increased production thus made possible, we have been obliged to decrease our average exportation of corn and wheat from nearly one fourth to only one tenth of our total production; and at the same time the average price of these great basic food materials has increased by 52 per cent., corresponding approximately to the increase in the value of land in the great corn and wheat states, and to the consequent and inevitable general advance in the cost of living.

You will remember that the population of the United States has increased 100 per cent. in thirty years, and without doubt will number more than 90 millions in 1910; but, notwithstanding the great areas of rich virgin lands brought under cultivation in the west and northwest, and notwithstanding the abandonment of great areas of depleted soil in the east and southeast, during the last forty years the average yield per acre of these two great grain crops has not even been maintained according to the twenty-year averages of the crop statistics of the federal government for the forty years from 1866 to 1905, as reported in the 1908 year book of the United States Department of Agriculture.

Shorter periods might be selected which would give apparent indications of a different tendency, but less than twenty-year averages are not trustworthy for ascertaining the average yield per acre; and these two twenty-year averages show that the decrease in yield of corn has exceeded the slight increase in yield of wheat, much of which, it should be remembered, is now grown on land less than forty years under cultivation. And this statement holds not only for the entire United States, but also for the great north central grain belt, including Ohio, Kansas, North Dakota and the ten other states lying within that triangle.

Thus, in this boasted "granary of the world," the records of forty years show that the average yield of wheat has increased one half bushel per acre, while the average yield of corn has decreased two bushels per acre.

Why should the average yield of corn in the United States be only 25 bushels per acre and the average yield in Illinois be only 35 bushels per acre, when the average yield upon the farm of the University of Illinois, on normal soil under practical, profitable and permanent scientific systems of farming, is 87 bushels per acre?

There are at least four factors involved in the solution of the problem of maintaining prosperity, civilization and universal education in this country. These four factors may be classified as exploitational, scientific, legal and economic.

1. Further exploitation of our remaining virgin soils, as by irrigation and drainage, neither of which is of large significance in comparison with the magnitude of our present agricultural development.

2. The restoration, by practical scientific methods, of depleted lands and large increase in productive power of practically all lands now under cultivation. This is the only great positive factor.

3. The legal control of increase in population by the enactment and enforcement of suitable laws.

4. The reduction in the standard of living, by extending the tendency already enforced to some extent, as in the gradual withdrawal of meat and other valuable food products from the daily diet, and adopting such standards as are common in China and Japan, where beef, butter and milk are practically unknown.

The greatest study of mankind is not man, but the application of principles upon which depends the preservation of man's prosperity and civilization; and this study must not only include the application of science to raise high the limitations of the production from the soil of necessary food supplies, but it must also include the application of sense in placing some just and necessary limitations upon the reproduction of the least fit of human kind.

CYRIL G. HOPKINS
UNIVERSITY OF ILLINOIS

ATTENDANCE OF STUDENTS AT FOREIGN UNIVERSITIES

The following table, which I have recently compiled, may be of interest to your readers.

These figures of attendance were furnished to the U. S. Commissioner of Education by the editor of *Minerva,* were printed by him in his annual report for 1908 (not summarized as here, but in detail for each institution, country by country), and are probably as complete as any which could be readily found or compiled. That these totals understate, rather than overstate, the attendance in some of the countries which have not taken the pains to prepare complete official statistics is highly probable; thus in SCIENCE, September 24, 1909, there are given figures quoted from Professor B. Menschutkin, writing in *Nature,* which claim a total attendance of students in the higher educational institutions of Russia for the years of 1908 and 1909, of 76,900, with the surmise of possibly 20,000 more in private higher colleges in different towns—a total of 96,900 as opposed to 54,208 given in the table for the year 1907 as a total of the figures furnished by the editor of *Minerva.*

I have not *Nature* at hand, but as quoted in SCIENCE Professor Menschutkin fails to state from what source his figures were drawn and I have therefore not been able to check them and, consequently, have not felt free to use them in this table in place of those having the sanction of "official" source. My own belief is that the total for Norway is considerably less than it should be if it represented complete results, but I have not, after due search, been able to find official supplementary figures. The same may be true in the case of some other countries, but the table is significant enough as it stands in the showing it makes of the widespread interest and participation in higher education.

Country	Population	Number of Students in Higher Educational Institutions, 1906–7	Population per Student
United States	83,941,510 (Est. 1906)	283,395[1]	296
		212,956[2]	394
Switzerland	3,463,609 (Cen. 1905)	10,511	330
France	39,252,267 (Cen. 1906)	50,935	771
Denmark	2,605,268 (Cen. 1906)	3,363	775
Germany	60,641,278 (Cen. 1905)	73,020[3]	830
Austria-Hungary	46,973,359 (Est. 1906)	51,691	909
Greece	2,631,952 (Cen. 1907)	2,836	928
Italy	33,640,710 (Est. 1907)	33,174	1,014
Belgium	7,238,622 (Est. 1906)	7,139	1,014
Netherlands	5,672,237 (Cen. 1906)	5,435	1,044
United Kingdom	44,100,231 (Est. 1906)	41,305[4]	1,068
Spain	18,831,574 (Cen. 1900)	15,642	1,204
Roumania	6,585,534 (Est. 1907)	5,336	1,234
Sweden	5,337,055 (Cen. 1906)	4,032	1,324
Portugal	5,423,132 (Cen. 1900)	3,923	1,382
Norway	2,321,088 (Est. 1906)	1,500	1,547
Servia	2,676,989 (Est. 1904)	1,022	2,619
Russian Empire	149,299,300 (Est. 1906)	54,208	2,754
Bulgaria	4.035.620 (Cen. 1905)	1,324	3,048

Population from "Statesman's Year Book," 1908. Number of Students from "Report of U. S. Commissioner of Education," 1908, Vol. I.

GUIDO H. MARX

ELECTIONS TO THE AMERICAN PHILOSOPHICAL SOCIETY

AT the annual elections for members of the American Philosophical Society on April 23, fifteen residents of the United States and five

[1] Including normal schools.
[2] Excluding normal schools.
[3] Including hearers.
[4] Excluding 22,159 "evening students."